North Carolina Agricultural Nutrient Assessment Tool (NCANAT), Version 2.02: Users Manual (Containing NLEW and PLAT)

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INTRODUCTION

North Carolina Agricultural Nutrient Assessment Tool (Version 2.01) contains two field-scale assessment tools: Nitrogen Loss Estimation Worksheet (NLEW) and Phosphorus Loss Assessment Tool (PLAT).

NLEW was developed in response to the Neuse Rules enacted in 1998. These rules represented a series of regulations that control point and nonpoint source nitrogen (N) discharges into the Neuse. As a result of the Local Option that was added to the agricultural best management practice (BMP) rules, producers can join a local strategy rather than implementing mandatory BMPs. The local strategy allows a county to determine where the approved BMPs can be installed to obtain the 30% N reduction. The local option also provides a few more alternatives to the list of BMPs, such as unfertilized cereal cover crops and no-till corn in the Piedmont, than the standard BMPs. In exchange for this flexibility, however, the rules mandated accountability. The accounting and tracking tool that has been developed to meet the requirements of the Neuse Rules is the NLEW. In addition, the NC Division of Soil and Water Conservation adopted NLEW in 1996 as the method to estimate BMP effects on relative nutrient dynamics for projects funded with Agriculture Cost-Share Program funds. It is also being used in the Tar-Pamlico River Basin.

PLAT was developed in response to the new USDA-Natural Resource Conservation Service (NRCS) nutrient management standard (590). The charge was given that each state must assess phosphorus (P) status during nutrient management planning if animal waste is involved or the field is within an impaired watershed. Three selection strategies were allowed (soil test, environmental test and P index). The NC Phosphorus Loss Assessment Committee chose a modified P index assessment method designed for NC conditions.

CD INSTALLATION INSTRUCTIONS

Insert the CD. Wait a few seconds and the NCANAT install program should display automatically. If it does not then go to the CD drive and click "Setup_New.exe". Continue to click the "next button". This will install the program on your hard drive at: Program Files/USI/NCANAT. If you want to change the path where the program is saved, you need to do so during the installation program. You will be shown the *Destination Directory* pathway. If you want the NCANAT installed at another location, change the pathway by clicking "browse". Scroll through the directories until you have the storage location for the program. If you are satisfied with the program storage location, click "next" and the program will be stored under Program Files/USI/NCANAT.

At the end of the install you will be asked if you want to run the program. If you do, click "yes" and then click "finish". This will allow you to use the program. Otherwise, click "finish".

There are two ways to store NCANAT on your desktop.

1. Go to the Windows Start Menu and click on Programs. Find NCANAT and right-click on it and select 'Send to --> Desktop (Create Shortcut)'.
2. Find the directory where "NCANAT.exe" is stored. Use your right mouse button to create a shortcut and drag the shortcut to your desktop.

UPDATING NCANAT AUTOMATICALLY

To update NCANAT (PLAT and NLEW) automatically with new files, click the "Download Updates" (the button to the far right) to automatically download any updates from the server of Understanding Systems Inc (where the program is located). However, you must be connected to the Internet BEFORE using this function. If you are on a T1, Cable, or DSL line then you are already connected. The program will automatically download the files into the correct folder.
The Download Updates button will always download the most current version files for NCANAT. If you already have the most current version, then it will not download the files. If problems occur during the download and update process and you need to re-download the files, right-click on the Download Updates button and click on 'Force Automatic Download.'

HOW TO USE NCANAT

The program allows users to run NLEW alone, PLAT alone or both NLEW and PLAT simultaneously. In the center of the program, toward the top, there are three buttons: NLEW, PLAT, and NLEW And PLAT. Click the button that corresponds to the program(s) you want to run and the necessary input boxes will be displayed.

Under the "Main Tab" are the following input boxes.

Identification

1. Calendar Year
   - The current calendar year will automatically display in the calendar year box. Should you want another year, use the pull-down menu to enter the calendar year. **For crops that span two calendar years, such as wheat, count the crop in the calendar year during which it is harvest.** For example, if your wheat crop were planted fall 1999 but harvested spring 2000, you would count your wheat crop for the 2000 calendar year.
2. Tract number
   - Enter the appropriate tract.
3. Producer ID
   - User can be identified numerically or alphabetically.
4. Field number
   - Enter the field number.

Location

1. County
   - Use the pull-down menu to select the county.
2. Soil mapping unit
   - Enter the predominant soil map unit of the field. Only soil mapping units found in your county will be listed.

Cropping System

1. Current Crop (NLEW only)
   - Use the pull-down menu to enter the crop for the current year. NLEW was not designed to work under pasture cropping systems. There will be NO NLEW calculation if the cropping system is any type of pasture.
2. Most Erosive Crop/Crop on which Manure is Applied (PLAT only)
   - If manure is applied every year, use the pull-down menu to enter the crop in the rotation that is the most erosive. If manure is applied to only one crop in a rotation, use the pull-down menu to enter the crop on which the manure is applied.
3. Field Slope (NLEW only)
   - Enter the average field slope. RYEs are determined for a 0-2% slope. Slopes greater than 2% are assumed to have

lower yields due to reduced water availability. The relationship between slope and yield reduction is curvilinear with much greater yield loss at higher slopes (>15% slope) than a moderate slope (3 to 8%).

4. Field Acres (NLEW only)
   - Enter the number of acres in the field
5. Cover Crop (NLEW only)
   - Select the cover crop type that was used. (Cover crop must be seeded by November 30 and killed no sooner than April 1 in the Coastal Plain and April 10 in the Piedmont to receive credit as a cover crop.)
6. BMP
   - Select the BMP and then click the arrow pointing to the right. If the BMP is a buffer, a new input box will appear. Use the pull-down menu to select the minimum buffer width (5 ft increments). Your field may be contiguous to another field rather than a stream or ditch. In that case the distance to the buffer is the distance from the field across any other fields plus the buffer. Also enter the number of acres affected by the buffer. (Acres affected is only for the NLEW portion of the program.) Continue to add as many BMPs as appropriate. Press "OK" after entering all appropriate information.

Nutrient Application

1. RYE (Producer Derived - NLEW only)
   - If the producer knows the crop RYE (average best 3 out of 5 years) for the soil series of the soil mapping unit, enter the value in units/acre.
2. N Application Rate (NLEW Only)
   - NLEW was only designed to work with commercial fertilizers. Enter the pounds of N applied per acre for the NLEW crop.

3a. Application Source and Rate Table (PLAT Only)
   - Enter the amount of the material that you are applying into the "Yearly_App_Amount" column, unless you are applying a fertilizer and you know the actual amount of P_20_5 that you are applying. The application units are in the next column (Application_units).
   - The amount of P_20_5 is listed in the column "lb_ P_20_5". If the material is animal waste, this column represents pounds of P_20_5 per unit applied. The column to the right, "Content_Unit", lists the units of the material. If you have your own waste analysis, change the value in the "lb_P_20_5" to reflect your value. Since the waste analysis is a crop coefficient value, the number will be multiplied by the appropriate amount so that it represents total P_20_5 contained in the waste. If you are working with fertilizers, you have two choices: Choice 1) if you know the amount of P_20_5 that you are applying, simply enter this value in the column that reads "lb_P_20_5". Choice 2) enter the amount of fertilizer you are applying in the "Yearly_App_Amount" column, then enter the P_20_5 analysis of the fertilizer in the "%_P_20_5" column. For example, if your fertilizer is 8-10-6 and you are applying 1000 lbs of fertilizer, one would enter 1000 in the "Yearly_App_Amount column and 10 in the %_ P_20_5" column. If you enter fertilizer information for "Choice 1 and 2", the program will select "Choice 2" over "Choice 1" in determining the amount of P that has been applied.
   - Double click on the line "AppMethod" in order to trigger the pull-down menu and then use the pull down menu to select application method.

3b. Application Source and Rate Table - Clearing values
   - If you have entered a value you want to change or delete altogether, double-click on the value. Only the value should be highlighted. Then either enter the new value or simply hit the "delete" key.
   - To change the selection in under the "AppMethod" column, double click on the line "AppMethod" in order to trigger the pull-down menu and then use the pull down menu to select either the application method or a blank entry.

Soil (PLAT only)

1. Soil Loss (t/ac/yr)
   - Enter the amount of erosion in t/ac/yr, calculated from RUSLE.
2. Receiving Slope Distance (feet)
   - Enter the receiving slope distance. The receiving slope is the concave slope extending from the base of the RUSLE slope to the field edge or to a source of concentrated runoff flow in a defined channel.
3. Soil Test (P-I)
   - Enter your agronomic soil test value (Mehlich III P Index).
   - A second soil test box may be visible for the 28-32" depth. If the box is visible, you will need to take a 28-32"

depth soil sample. Enter the P soil test value for this sample.

4. Weight:Volume (W/V) Ratio
   - Enter the W/V ratio from your soil sample for the agronomic soil depth sample. **It is very important that you use the W/V value from your soil test if it is available.** If you do not have this value, a default ratio will be provided based on your soil mapping unit.
   - Enter the W/V ratio from your sample for the deep soil depth sample (28-32"). **It is very important that you use the W/V value from your soil test if it is available.** If you do not have this value, a default ratio will be provided based on your soil mapping unit.

Calculating Surface and Subsurface Water Losses for PLAT: Drainage and Hydrologic Condition

PLAT utilizes two separate modeling approaches to estimate soluble P losses, both across the surface and through the soil profile. These are the curve number approach and the Drainmod Approach. On wet soils with shallow water tables a DRAINMOD based approach is used to account for the effect of water table depth on infiltration in these areas, subsurface drainage, and other factors. On all other sites, a modified SCS Curve Number approach is employed. The developers of PLAT recognize that these two models are not correlated.

If a soil mapping unit is poorly drained or has a high water table, you will be asked if the soil is drained. Click "Yes" if the soil is drained with either parallel drains or irregularly spaced drains. Soils with regularly spaced parallel drainage ditches are easy to identify. Sometimes these soils will not be drained, in which case you should select "No". Sometimes these soils, however, will have irregular drainage systems. You will need to determine the effective spacing for these fields. Follow the instructions below to calculate drainage spacing for irregular drainage systems.

For irregular systems, divide the area of the field served by the drainage (in square feet) by the total linear feet of drains (open ditches and tile lines). This will be the drainage spacing. For areas of the field that do not have shallow water tables and do not require drainage due to topography or soil type, a PLAT rating may be calculated separately as undrained using the appropriate soil mapping unit for this portion of the field.

Drainage (PLAT only)

1. Artificial Drainage
   - This box will only be viewable if the soil is a poorly drained soil, otherwise this box will not be viewable, but you will have the option to enter information in the Hydrologic Condition box. If the field is drained, even if the drainage is irregular, this should be considered a drained soil. Click "yes" to denote a drained field.
   - For regularly spaced drainage ditches or tile drainage, simply enter the required spacing and depth information. To compute the drainage spacing for irregularly drained soils, calculate the area drained and divide by the total length of the drainage (which may include streams, ditches, or tiled drainage). Enter this number as your drain spacing. Determine the average depth of the drainage devises and enter this as your drain depth.
   - If the field is not drained, and you click "NO", then proceed to Hydrologic Condition.

Hydrologic Condition (PLAT only)

1. If there is only one hydrologic condition, that condition will already be checked. If there is more than one hydrologic condition, you will need to check the appropriate condition. Hydrologic condition is based on factors that affect infiltration and runoff, including density and percent canopy of vegetation, amount of year round cover, amount of grass or close seeded legumes in rotation, percent of surface residue cover, and surface roughness.
   - Cropland choices are Good or Poor. A poor condition is a finely prepared seedbed, not drilled, with a low plant population, and not in rotation with a sod. A good condition is rough seedbed, high plant population, and in rotation with sod, high residue-producing crop, or conservation tillage.
   - Pasture choices are Good, Fair, or Poor. A poor condition is over-stocked, under fertilized, low year-round plant population and poor plant condition. A good condition is properly stocked, adequate nutrient management, and a full plant population (nearly 100% cover). A fair condition is represented by factors less than "Good" and better than "Poor", and is determined at the planner's discretion.

Calculate

1. Press the "Calculate" button at the bottom of the screen. The output will be calculated and the value will be displayed next to the calculate button.
2. If PLAT has been run, each P loss pathway is expressed in terms of an index and the total assessment is stated both

verbally (low, medium, high, or very high) and numerically.
3. If NLEW is run, the total N loss for the field is stated in lbs N/field.

Compare (NLEW and PLAT)

The "Compare" button allows you to compare the reduction or addition of phosphorus, nitrogen, and sediment for the **same** field but under different management. This function is intended to be used primarily to determine the reductions in nutrients and sediment due to the implementation of best management practices (BMPs). The phosphorus portion is only associated with gains or losses due to sediment-attached phosphorus. The other phosphorus loss pathways are not considered. To use the compare function, follow the instructions below:

1. Save each run you want to compare (see "Record Buttons").
2. Press the "Compare" button. A box with two sides will display. All saved files can be viewed in the left-hand side of the box. Select the file with field conditions before BMP implementation and then click the right arrow button to move the file into the right-hand side of the box. Then select the file with field conditions after BMP implementation and click the right arrow button to move the file into the right-hand side of the box. Finally, click "OK." The program will automatically make the reduction or addition comparisons for sediment, nitrogen, and/or phosphorus. Information on the additions or reductions will be displayed in the compare box. The reductions or additions are stated as pounds (lbs) per field for phosphorus and nitrogen and t (tons) per field for sediment.
3. To print the information, simply click the "View/Print Results" button like you would any other calculation. The original calculation results for each of the comparison runs will be displayed followed by the comparison results.
4. Comparisons cannot be saved. Only the original files from which the comparison is derived is saved - not the comparison.
5. Comparisons cannot be completed if the Mapping Unit or any component of the Field Identification is different between the two records.

View/Print Results

1. Press the "Print Results" button to view details of the inputs and outputs for the current run. For a listing of inputs and outputs see Appendix 1.
2. Click "Print" to obtain a printed copy or click "Print to file" to save the output as a text file.
3. Comments can be appended to the output by pressing the "Add Comments" button.

Record Buttons

1. Save Button
   - Press the "Save Record" button to save the file. You will need to name the file. It is suggested that you save files under the following file names: Tract number - field number - Year. All files will be saved consecutively. The files are saved under the name you gave the file and are saved in the following path: Program Files/USDA/NCANAT/UserTables/UserInputs.DBF. Files can be overwritten. Once you have saved the record, it can then be imported into databases or spreadsheets.

1a. Importing Save Records into Access

- Open Access. A box will come up for you to choose: Blank Database, Database Wizard, or Open an Existing Database. Choose 'Blank Database' and click "OK".
  - Once you click "OK" another box will come up titled, 'File New Database'. In the 'File name' box at the bottom will be a file called 'db1.mdb.' This is the default file that you can change to any name you want (the extension still has to be .mdb though). Once you are satisfied with the name click the "Create" button to the right.
  - A window will come up with multi-tabs. The first tab is 'Tables' which is what you want. Click the "New" button to the right.
  - In the next window that appears, choose 'Import Table' and click 'OK'.
  - In the next window that appears, go to 'Files of type' on the bottom and choose 'dBase IV (*.dbf)'. There are many different dbase tables so make sure you select the right one.

- Browse through your directories and select whatever DBF File you want to view and click the 'Import' button.
- Any table or tables selected will be put into the .mdb file that you named earlier.

1b. Importing Save Records into Excel of Dbase

- To import the contents of the table into a database or spreadsheet program, such as Excel or DBase, start the pr2.
- Open the program you want to use. Then use "open a file" option and find the following path: Program Files \USDA\NCANAT\UserTables\UserInputs.DBF. When you get to user tables, select "all files". (Selecting "all files" will allow all the data base files to be visible.) This brings all stored records into your database.

2. New Record Button
   - Click the "New Record" button to start a new run. All records will clear.
3. Find Record Button
   - To find a record, click "Find Record". You will be asked for the name used to save the record. Type in the record name and information will appear in the input boxes.

Tabs

1. Main
   - Input boxes for NLEW, PLAT or NLEW/PLAT programs.
2. Record View
   - This table allows you to see each input you have made to a record. To move through the records, either use the scroll bar on the far right-hand side or the scroll bar on the bottom. You can select a record by clicking on the gray box on the far left-hand side next to the record you are interested in.
   - Once you have clicked on a record, the information for the record you have indicated will be in the input boxes when you return to the input table.
3. View Tables
   - To view any of the tables used in NLEW or PLAT, click "View Tables" and select the data table you want to view. You will be able to scroll through the data tables and view the information. You cannot, however, change any of the values. The button, "Process List" allows large data sets to be calculated automatically. If you have a large data set, simply bring it into the program and then click "Process List".
4. Watersheds
   - Under the NRCS 590 Nutrient Management Standard, if a water resource is impaired by agriculture, then a PLAT analysis must be run even for fields to which only commercial fertilizer is applied. The list of impaired water resources and the subwatersheds that must conduct a PLAT assessment for commercial fertilizer plans is identified
.
5. About NLEW_PLAT
   - To read about NLEW or PLAT, click on this tab.
6. Credits
   - Information on persons responsible for the conceptual development and the programming is listed.

Symbols at the Top

1. Arrows
   - Allows you to move between records. Left facing arrow moves you back - Right facing arrow moves you front. Click the arrows to move forward and backward.
2. Negative
   - Allows you to delete a record. Click the negative sign to delete a record.
3. Binoculars
   - Allows you to search the data base to find a stored record. Use the pull-down menu to find the column name under which the information is stored. Then enter the specific information you are looking for when you are asked to enter "record item of the information you are looking for". For example, if you are trying to find an entry that had a Lenoir soil type, select the "Map Unit" from the pull-down menu and then enter Lenoir. The record will automatically be entered.
4. Exit
   - Click "exit" to exit the program.

DESCRIPTION OF THE NC APPORACH TO PHOSPHORUS LOSS ASSESSMENT

In 1999, the Phosphorus Loss Assessment committee was formed to respond to address the changes in the NRCS nutrient management policy and standard 590. This committee is composed of members of NRCS, the NC Division of Soil and

Water Conservation, the NC Department of Agriculture & Consumer Services, and 11 faculty members at NC State University.

Of the three options offered by the NRCS policy and standard (soil test, soil-threshold, and P-Loss Index), the NC P Loss Assessment Committee strongly endorsed the P-Loss Index concept. The other two approaches will be effective in NC only as components of an overall P Loss Assessment. In order to avoid confusion with the agronomically based NCDA&CS "P-Index" provided on the soil test report, NC will use the term "P Loss Assessment Tool (PLAT)" for the P-Loss Index.

The committee examined the P-Loss Index approaches proposed by NRCS national staff and those proposed in other states to see how well these approaches might work in NC. These approaches either assumed loss occurred primarily through a single loss pathway (erosion), or focused on a single system (i.e. poultry litter on pastures). In addition, enormous reliance was placed on best professional judgment in defining loss criteria and values, as well as weighting the relative importance of the criteria. Each of the proposed methods had serious limitations for use in NC, where agricultural operations occur on 7 soil orders including over 480 soil series and nearly 2000 map units that encompass all drainage conditions and nearly all particle size classes. Animal wastes come from dairy, beef, swine, layers, broilers and turkey operations, and each region of the state has unique animal and cropping system traditions. In addition, NC rules in the Neuse and Tar Pamlico river basins required nutrient management plans for fertilized fields to meet the new standard as well, a condition not experienced in other states. Because of the enormous diversity of situations encountered within the state, it became apparent NC needed to develop a method that allowed analysis of each loss pathway separately for each site that did not prejudge the dominant loss mechanism. Using this generic approach and site-specific factors, only the appropriate source and transport factors are used to calculate loss potential. Each loss pathway is assigned a relative index for that factor based on acceptable losses. The final results from each pathway are summed to obtain the overall PLAT rating for the site.

Loss Pathways

Phosphorus loss occurs through four major processes. One or more pathways may contribute to significant P loss for a site.

1. Sediment Carrying Soil-bound P

The largest P source in a field is the soil. Sorting of soil particles that naturally occurs during erosion results in soil particles (clays) with the highest P concentration transported in surface runoff. Soils with higher soil test P levels exhibit higher P content in eroded particles. Site-specific factors that reduce sediment delivery to the stream (erosion control practices, redeposition of sediment in the field, retention beyond the field edge or in buffers, ponds and controlled drainage) reduce P loss.

2. Runoff Carrying Soluble P

For a given soil, dissolved P concentrations in runoff increases proportionally as soil test P increases. The soil P released to runoff at a given soil test level varies with soil texture, organic matter content, and types of soil minerals. There are no known BMPs to reduce soluble P losses.

3. Subsurface Soluble P Losses Connected with Surface Water

Direct movement of P from soil to surface water is possible on sites with tile drains and ditches that enter surface waters. Soils with high P content and moderate or lower P retention capacity may also contribute to surface water through leaching and lateral flow from the field, since a high percentage of the near-surface groundwater feeds into surface water channels.

4. Runoff Carrying Source P Applied to the Surface

There is a strong relationship between P application rate (as manure or fertilizer) and P concentration in runoff following applications. In manured or fertilized fields, P concentration in surface runoff increases with the application rate, the amount of applied P remaining on the soil surface, and the solubility of the applied P.

Factors Used by the PLAT

<u>Loss Pathway 1.</u> Total P Loss Potential from Erosion (Particulate P)

FACTOR	***COMMENTS***
Soil Erosion Rate	RUSLE as affected by soil, slope, residue management, tillage and cropping

practices.

Soil Test P & Clay Content — Total P Concentration associated with sediment.

Receiving Slope Width — Estimate edge of field delivery of sedimentation.

Fe-P Fraction — Readily available component of sediment-bound P, specific to soil groups.

Buffer Width — Retention of sediment-bound P.

P-retaining Practices — Controlled drainage, ponds, and sediment basins.

<u>Loss Pathway 2.</u> Surface Soluble P

FACTOR	*COMMENTS*
Soil Test P and Soil Management Group	P concentration supported in runoff (soil specific).
Estimated Runoff (inches per year)	
No artificial drainage	Improved curve number method (crop, residue level, and soil specific). Uses long-term (40+ years) county specific rainfall records, daily average runoff calculated, with antecedent moisture conditions accounted for.
Artificially drained	Based on drainage depth and distance between drains, and soil properties with depth, a Drainage Index (DI) is calculated. Runoff is calculated based on DI, Crop, and average county rainfall DRAIMMOD based.

<u>Loss Pathway 3.</u> Subsurface Soluble P

FACTOR	*COMMENTS*
Soil Test P	Initial estimate of P concentration supplied to subsoil layers. Soil Test P- at 30 in depth. Estimate of P concentration in subsurface flow.
Very High P Retention or Other	Likelihood of P Movement from surface to beyond 30 in depth. Database value, soil specific.
Estimated Subsurface Flow (in/yr)	
No artificial drainage	Annual Rainfall-ET-Runoff (See Table 2). ET is based on Penman-Monteith equation, utilizing crop, soil, and local climatic data.
Artificially drained	Drainage Index (Table 2), crop and local rainfall specific. DRAINMOD based.

<u>Loss Pathway 4.</u> P Loss from Applied Sources (Source P)

FACTOR	*COMMENTS*
Application Rate	Amount of P applied.
Application Method	Surface exposed P remaining after application.
P Source	% P in the material that is applied and its relative solubility.
Soluble P Attenuation Factor	Fraction of soluble P attenuated in the field.
Non-Soluble P Attenuation Factor	Fraction of non-soluble P attenuated in the field.
Application Rate	Amount of material applied.
Runoff Fraction (See Table 2)	Runoff/Annual Rainfall. Used to estimate maximum loss potential.

Buffer Width Retention of non-soluble P.

PLAT Ratings

Rating	**PLAT Value**
Low	0-25
Medium	26-50
High	51-100
Very High	>100

Overall PLAT Assessment

Loss Pathway	*PLAT Value*
1. Particulate P	
2. Runoff Soluble P	
3. Subsurface Soluble P	
4. Source P	
TOTAL	

- If the total of all pathways is 0 to 25, then the assessment rating is deemed Low. If the total of all pathways is >25 to 50, then the assessment rating is deemed Medium. A Low or Medium Rating allows animal waste to be applied on a N basis.
- If the total of all pathways > 50, then the assessment rating is deemed High. A High Rating allows animal waste to be applied at a crop P removal rate.
- If the total of all pathways >100, then the assessment rating is deemed Very High. A Very High Rating only allows starter P to be applied.

Advantages of the NC Phosphorus Loss Assessment Tool

- Best Professional Judgment minimized
- One tool works for all situations. Multiple worksheets with different ratings based on regions, manure systems or cropping systems eliminated.
- Use standard, routine inputs where possible:
    - Soil mapping unit
    - Erosion Rate (RUSLE)
    - Soil Test
    - Current type of manure, application rate and method
- Specific estimates based on local conditions, management
    - Runoff, Leaching (Soil, crop, residue management, local climate)
    - Soil test - 30 in depth
    - Buffers, Sediment trapping practices, Proximity to surface water
- Implemented Best Management Practices are integrated into the assessment process. This allows PLAT to be used as a planning tool as well as an assessment tool.

Additional information on PLAT can be found at http://www.soil.ncsu.edu/nmp, under the section Phosphorus Loss Assessment Tool.

DESCRIPTION OF FIELD-SCALE N LOSS ESTIMATION WORKSHEET (NLEW)

Since NLEW will be applied to a minimum of 120,000 fields in the Neuse River Basin (average field size is =10 acres), input data needed should be readily attainable. Inputs needed are soil type for the field, crop, field size (acres), N fertilizer rate (lb/ac), realistic yield expectation (RYE) for the crop, cover crop type (if grown), use of BMPs and the area that the BMPs affect. Algorithms for the field-scale NLEW can be found in Appendix 2.

Realistic yield expectations, which are defined as the best three out of five years of yield, can be determined using two methods: 1) the producer can enter the information or 2) the data can be automatically retrieved from the NC RYE data table based on soil series. This RYE data table has recently been developed by an interagency group comprised of personnel from NC State University, NCDA&CS, NCDSWC, and USDA - NRCS for16 agronomic crops and all the agricultural soils in North Carolina (Hodges, 2000).

Once the RYE is obtained, it is multiplied by a N factor. This multiplied value is the N fertilization rate necessary to produce an optimum yield of that particular crop. (See table below for the N factors.) In NLEW, this N fertilization rate is referred to as the *RYE N Rate*.

Table 1. N factors for North Carolina crops

Crop	Use	N, lb	Unit of yield or application area
Barley	Grain	1.4 to 1.6	Bushel
Corn, grain	Grain	1.00 to 1.25	Bushel
Corn, silage	Silage	0 to 12	Ton
Cotton	Lint	6 to 12	100 pounds of lint
Oat	Grain	1.0 to 1.3	Bushel
Rye	Grain	1.7 to 2.4	Bushel
Sorghum	Grain	2.0 to 2.5	100 pounds
Soybean	Grain	3.5 to 4.0	Bushel
Triticale	Grain	1.4 to 1.6	Bushel
Wheat	Grain	1.7 to 2.4	Bushel
Bermudagrass	Hay	40 to 50	Dry ton
Orchardgrass	Hay	40 to 50	Dry ton
Pearl Millet	Hay	45 to 55	Dry ton
Small grains	Hay	50 to 60	Dry ton
Sorghum-sudangrass	Hay	45 to 55	Dry ton
Tall fescue	Hay	40 to 50	Dry ton
Timothy	Hay	40 to 50	Dry ton
Hardwood	Trees	70 to 100	Acre
Pine	Trees	40 to 60	Acre

All NC agricultural soils have been placed into soil management groups (Hodges, 2000a). Soils are grouped based on physiographic region (Coastal Plain, Piedmont, and Mountains), drainage, productivity, texture, parent material, and landscape position. Each soil management group has been assigned a N factor for every crop based on soil management group characteristics. The N factors used in NLEW are automatically imported from the N factor data table.

If the *RYE N Rate* is less than the *Current N Rate* (the current applied N rate), the extra N will be partitioned into *Excess N* - that is the N fertilizer that the crop cannot use. It was decided, based on the research of Jacobs and Gilliam, that 5% of this excess N would be lost through surface flow processes and the remaining (95%) excess N lost through subsurface flow processes. It is further assumed that N lost through surface flow does not undergo any transformations that reduce its delivery. N lost through subsurface flows can be reduced by appropriate BMPs.

Optimal crop production requires N application beyond the amount that can be used by the crop. Agronomists have developed fertilizer N use efficiency (NUE) values to indicate the % of applied N that is actually utilized by the crop and can be recovered in crop tissues. Fertilizer NUE values were derived primarily from experiments conducted in NC unless there was no data available. In general the NUE values are calculated for both the harvested portion of the crop and the stover. Since most NUE values were determined using the difference method and results are based on the stover from the prior year's crop being left in the field, we assumed that the system was at semi-steadystate for net N mineralization. The *Crop N Uptake* is multiplied by 1- NUE, which is the N that is not absorbed by the crop and can be leached through the soil and into the shallow groundwater. Since NLEW is a not a model and we are not trying to account for all N sources or N cycling such as net mineralization and denitrification). The assumption is made that all the fertilizer N not used by the crop moves below the root zone.

The two subsurface N sources - from excess fertilizer applications and from fertilizer not utilized by the crop - are summed. If a cover crop is planted, it is assumed that some of this excess N is absorbed by the unfertilized cereal cover crop. Much of this N absorbed by the cover crop will be released to the subsequent crop. Thus the N reducing value assigned to the cover crop is N that is stored in the soil organic matter pool and released in an unpredictable manner over a long time period. For a cropping season we have assumed this N is removed from the system completely (Table 4). In order to receive N-reducing credit for cereal cover crops, the crop must be planted by November 30 and killed no earlier than March 31 in the Coastal Plain and April 10 in the Piedmont. The range for N-reducing values for cover crops is between 5 to 15%, depending on the crop type. If a cover crop is grown, then the *Subsurface N* is multiplied by 1- % N Reduction (cover crop), leaving subsurface N that can be further reduced by additional BMPs.

Research at NC State University has demonstrated that both riparian buffers and controlled drainage structures can reduce subsurface N flow to ditches and streams from 40 to 95% (Gilliam et al., 1997). In NLEW, the subsurface N can be affected by either of these BMPs. However, the area affected by these BMPs may not be the same area as the field area. Therefore, if the amount of area affected by the BMP is less than the field size, the area must be determined. Again the *Subsurface N* is multiplied by 1-% N Reduction (BMP). The remaining *N Subsurface Loss* is added to the *N Surface Loss* to leave the *Estimated N Leaving Targeted Area.* This designation of a targeted area is not meant to imply an edge of field or stream loading N loss but rather the end of the accounting process.

Default Values Used In The System

N Fertilizer Use Efficiency Values

NLEW currently partitions N into three pools: N in excess of crop needs if the crop is overfertilized, N absorbed by the crop, and N intercepted or transformed by BMPs. To determine the AVERAGE efficiency of crops that use N, a literature review on the N fertilizer use efficiency of the major crops was conducted from research results in North Carolina or other states. Once these values were collected and synthesized, they were reviewed and finalized by the following researchers: Drs. Steve Hodges, Gene Kamprath, Deanna Osmond, Noah Ranells, and Michael Wagger. In addition, the values were presented, discussed, and agreed upon by the entire NLEW committee (Table 2).

Table 2. N Fertilizer Efficiency Values

Crop	**N Use Efficiency (%)**	**Reference**
Bermuda Grass	75	Woodhouse (1969)
Flue-cured Tobacco	50	Sisson (1991)
Burley Tobacco	40	MacKown (1996)
Corn - Coastal Plain	55	Chancy(1982), Kamprath (1986), Wagger(1992)
Corn - Tidewater	40	Chancy (1982), Kamprath (1986), Wagger(1992)
Corn - arenic	40	Chancy (1982), Kamprath (1986), Wagger(1992)
Corn - CP & irrigated	65	Chancy (1982), Kamprath (1986), Wagger(1992)
Corn - Pied & conv	40	Wagger (1996)
Corn - Pied & notill	55	Wagger (1996)
Corn - Mountains	50	Hoyt (2003)
Sweet Potato	40	Ortega (1996)
Cotton	50	Torbert (1994)
Cucumber	30	Osmond (1999)
Wheat	55	Osmond and Weisz (2003)

Best Management Practices

The entire NLEW committee, along with other members of the NC State University Soil Science Department went through the North Carolina State agricultural cost-share list to determine which of the cost-shared BMPs were capable of reducing the N not absorbed by the crop. Excess N left in the soil profile or moved into the shallow ground water can either be absorbed by a subsequent crop (for example, a rye cover crop) or intercepted and transformed (for example, riparian buffers). As a result of that meeting, the following BMPs were determined to reduce excess N. Most of these values have years of research to support the reduction value associated with each practice. These values were sent to Dr. Robert Evans for his review and comment. He concurred with the values that were presented. There were several people in the committee that felt that 90% effectiveness for riparian buffers was too high and that a more realistic value of 80% should be used. The riparian buffer value was reduced to 85%.

State Cost Shared Practices

Sediment/Nutrient Delivery Reduction from Fields

Practice	N Reductions (%)
Filter Strip (next to water body)	40
Grade stabilization	0
Nutrient management	**
Riparian buffer (50 feet)	85
Rock-lined outlet	0
Sediment control basin	0
Water control structure	40
Streambank stabilization	0

**NLEW considers nutrient management through reduction in fertilizer application. The efficiency of nutrient management will vary.

Erosion Reduction/Nutrient Loss Reduction in Fields

Critical area planting
Cropland conversion
Water diversion
Pasture land conversion
Terraces
Conservation tillage
Long term no-till
Sod-based rotation
Strip cropping

An underlying assumption of NLEW is that the majority of N lost is subsurface soluble N. Erosion practices, although effective in reducing erosion and surface losses of N, do not have a proven effect on the majority of N in agricultural systems. Since most N is lost through subsurface flow, these practices have little affect on the overall N loss budget. In addition, some of these practices will be accounted for in the current year that it is implemented. For example, if cropland is converted to pasture, the reduced N loading will be accounted for in the pasture crop and its higher N use efficiency.

Agricultural Chemical Pollution Prevention

Agri-chemical handling facility (not relevant)

Proper Animal Waste Management Practices

Animal waste lagoon closure
Constructed wetlands
Controlled livestock lounging area
Dry manure stack
Heavy use protection
Insect control
Odor control
Storm water management
Waste treatment lagoon/storage pond
Waste/animal composter
Waste application system

Animal waste application is treated as any nutrient application. No specific numbers will be assigned to these practices.

Stream Protection from Animals

Heavy use area protection
Livestock exclusion system
Spring development
Stock trail
Stream crossing
Trough or tank
Well

Windmill

While some of the above BMP systems have demonstrated a significant effect on water quality of receiving waters, there is no standard effect with regard to N reduction. The site-specific nature of BMPs is relative to pre-BMP management practices as well as topographic and hydrologic aspects of a particular site.

Cover Crops

The effectiveness of cover crops to reduce N in the soil profile is a function of how much the crop can absorb (which depends on planting date, kill or plow-down date, and growth patterns) and the subsequent mineralization and release of the N in the cover crop residue the following year. Researchers at NC State University conducted ^{15}N research on cover crops. At the realistic corn fertilizer rate of 150 kg N/ha, rye accumulated approximately 35 kg of N/ha by the middle of April whereas wheat had accumulated only 20 kg/ha of N. This difference in N content is due primarily to difference in total biomass accumulation: 3,000 kg/ha (rye) vs 2,000 kg/ha (wheat). Although wheat accumulates about 2/3 the N and biomass as rye, soil nitrate concentrations and subsequent release of N are very different. Soil N concentrations in March and April are much higher under wheat than rye. In addition, wheat releases its N faster than rye although both crops release most of the N accumulated during their growth by the 16th week after the crop is killed.

Using these results, we determined that an average 15% net reduction (uptake minus mineralization) in N was an appropriate value to assign early planted (before November 30), late killed (April 1st in the Coastal Plain, April 10th in the Piedmont), and unfertilized rye cover crop. Oats are intermediate to rye and wheat in its ability to absorb N. A value of 10% for early-planted, late killed, nonfertilized oats would be reasonable. Based on the lower total crop N content of wheat, its faster mineralization rate, and the fact that soil nitrate levels were much higher for wheat, we assigned a 5% N reduction value. Again this is for early planted, late killed, unfertilized wheat.

No-till and Strip-till

During a national conference on no-till, it was concluded that no-till had little effect on increasing or decreasing N movement into shallow ground water (Logan, 1987). Under some unique conditions, with certain crops, no-till may reduce subsurface losses of nitrate-N. The available data from the Piedmont of North Carolina demonstrate that at the same N fertilization rates, yields of no-tilled corn are much greater. The very large and sustained corn yield increases in the Piedmont region of North Carolina suggest that N is used more efficiently under no-till systems and subsurface N losses are probably reduced. This is why we have assumed greater fertilizer N use efficiency with no-till corn than conventional corn in the Piedmont.

Most of the data reviewed from both the U.S., the Southern region, and North Carolina supports the conclusion that tillage type has no proven effect on N movement into the shallow ground water. After summarizing the available data and submitted the product to outside reviewers, it is our determination that no-till systems without a cereal winter cover crop do not represent an N-reducing BMP in the Coastal Plain of North Carolina for any crop. This does not preclude the use of no-till or strip-till planting techniques to reduce production costs and reduce sediment losses. Agricultural systems of best management practices should include practices that reduce all pollutants. Osmond et al. (2000) presented a summary of N losses from no-till and strip-till.

Based on available research and professional judgment, the follow N reducing credits for the different best management practices have been determine (Table 3).

Table 3. Best management practice interception efficiencies for N

Best Management Practice	**N Reduction (%)**
Filter strip (Minimum of 20 feet)	40
Waster control structures (flashboard risers)	40
Riparian buffers	
Minimum 50-foot width (30 ft trees, 20 ft grass)	85
NRCS standard	85
Minimum 20 ft trees only	75
Minimum 30 ft grass only	65
Cover crop	
Rye & Triticale	15

Oats & Barley	10
Wheat	5

Future Revisions

We request that users of the NLEW tool provide feedback to the authors or other NC agricultural agency personnel so that we can provide future versions that incorporate user comments and suggestions. The NLEW working group will continue to consider modifications to the current version as results from applied research in NC, the Southeast, and elsewhere becomes available.

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APPENDIX 1: INPUTS and OUTPUS for NLEW and PLAT

Inputs for NLEW consist of

1. Calendar Year
2. Producer Identifier
3. Tract Number
4. Field Number
5. County
6. Mapping Unit (Soil Series)
7. Crop (Current Crop) & Tillage
8. Field Slope
9. Field Acres
10. Cover Crop
11. Crop NUE (N use efficiency which is pulled from a data table)
12. RYE (either producer supplied or determined from the data base table using the appropriate RYE based on soil mapping unit, field slope and crop)
13. NFactor (N factor taken from the data base and used to determine total N needs)
14. N Application Rate. This information is derived from the Application Source And Rate table. In NLEW, this is the amount of N fertilizer supplied to the crop.
15. Recommended N Application Rate. This N recommendation is based on the RYE and N factor.
16. BMPs (best management practices that reduce N losses)
17. BMP Acres Affected (the number of acres that are affected by the BMP)

The outputs for NLEW are as defined below:

1. N_Applied = the amount of N applied by the producer.
2. N_Needed = the appropriate N fertilization rate as determined by RYEs and N factors.
3. Excess_N (Field acres) = if the total amount of N applied to a field is greater than the recommended application amount, then there will be excess N.
4. Excess_N_Surface = of the excess N that is applied, this is the amount that is lost through surface processes.
5. Excess_N_Subsurface = of the excess N that is applied, this is the amount that is lost through subsurface processes.
6. N_Needed_Field = amount of N recommended on a field-basis. This amount is determined either from the user-supplied RYE or the database supplied RYE and multiplied by the size of the field.
7. Utilized_N_Crop = the amount of N used by the crop. This is determined by the recommended N amount multiplied by the N use efficiency factor (NUE).
8. N_Lost After Crop = the amount of N not used by the crop. It is the N_Needed - Utilized_N_Crop.
9. N_Lost Before BMPs = the amount of N not absorbed by the crop + the excess N in the subsurface due to excess N application. This N can be lost to the shallow ground water. To obtain N_Lost Before BMPs, N_Lost After Crop and Excess_N_Subsurface are added.
10. N_Lost_After_Cover_Crops = the amount of N remaining in the soil that can be lost to the shallow ground water after a cover crop has been utilized.
11. N_Lost_After_BMP = the amount of N remaining in the soil that can be lost to the shallow ground water after a BMP has been utilized.
12. Total_N_Lost = both the N lost through surface and subsurface processes.

Some of the inputs for PLAT are identical to NLEW: Calendar Year, Producer Identifier, Tract Number, Field Number, County, Soil Mapping Unit, Crop and Tillage, and BMPs. Some of the inputs, however, are different. These unique inputs may include:

- Soil Loss
- Fertilizer information: type of material, analysis, application method
- Receiving Slope Distance
- Soil Test (agronomic depth)
- Soil Test (at the 28" - 32" depth), if it is used
- Weight:Volume (optional)
- Hydrologic Condition or Drainage Spacing and Depth.

The outputs for PLAT are simply the indexed ratings for each of the four loss pathways and the total rating.

APPENDIX 2: ALGORITHMS FOR FIELD-SCALE NLEW

1. Calculate RYE N

IF RYE_producer available
    THEN RYE_producer (bu/A) * RYE_N (by soil, by crop) (lb/bu) = N_needed (lb/A)
ELSE RYE_table (by crop, by soil) (bu/A) * RYE_N (by soil, by crop) (lb/bu) = N_needed (lb/A)

2. Determine if Fertilizer N Applied is Excessive and Distribute Between Excessive Surface and Excessive Subsurface

IF N_application_rate (lb/A) > N_needed (lb/A)
    THEN N_application_rate (lb/A) - N_needed (lb/A) = Excess_N (lb/A)

Excess_N (lb/A) * A * 0.05 = Excess_N_surface (lb)

Excess_N (lb/A) * A * 0.95 = Excess_N_subsurface (lb)

ELSE Excess_N_surface = 0 (lb)
    and Excess_N_subsurface=0 (lb)
    and N_application_rate (lb/A) = N_needed (lb/A)

3. Put Fertilizer N on a Poundage Basis

N_needed (lb/A) * A = N_needed_A (lb)

4. Determine N Lost after Used by Crop

N_Needed_A (lb) * (1.0 - CropNUE) = Crop_N_lost (lb)

5. Determine Total Subsurface Loss

Excess_N_subsurface (lb) + Crop_N_lost (lb) = N_lost (lb)

6. Determine Effect of Cover Crop

N_lost (lb) * (1.0 - Cover_crop_coef) = N_lost_cover (lb)

7. Determine Effect of Other BMPs

IF Acre = Acres_effected THEN N_lost_cover (lb) * (1.0 - BMPCoef) = N_lost_sub (lb)
    ELSE Acre > Acres_effected then
        N_lost_cover (lb) * (1- (acres effected/acres)) = N_lost_1 (lb)
        N_lost_cover (lb) * (acres effected/acres) * (1-BMPeffect) = N_lost_2 (lb)

8. Determine Total N Losses

(N_lost_1 (lb) + N_lost_2 (lb) + Excess_N_surface(lb)) or (N_lost_sub (lb) + Excess_N_surface(lb)) = Total_N_lost (lb)